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Urethral strictures after bipolar transurethral resection of prostate may be linked to slow resection rate

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Purpose: This study aimed to determine the urethral stricture (US) rate and identify clinical and surgical risk factors associated with US occurrence after transurethral resection of the prostate using the bipolar Gyrus PlasmaKinetic Tissue Management System (PK-TURP).

Materials and Methods: This was an age-matched case-control study of US occurrence after PK-TURP. Retrospective data were collected from the hospital records of patients who had a minimum of 36 months of follow-up information. Among the data collected for analysis were prostate-specific antigen level, estimated prostate weight, the amount of prostate resected, operative time, history of urinary tract infection, previous transurethral resection of the prostate, and whether the PK-TURP was combined with other endourological procedures. The resection rate was calculated from the collected data. Univariate and multivariate analyses were performed to identify clinical and surgical risk factors related to US formation.

Results: A total of 373 patients underwent PK-TURP between 2003 and 2009. There were 13 cases of US (3.5%), and most of them (10 of 13, 76.9%) presented within 24 months of surgery. Most of the US cases (11 of 13, 84.6%) occurred at the bulbar urethra. Multivariable logistic regression analyses identified slow resection rate as the only risk factor significantly associated with US occurrence.

Conclusions: The US rate of 3.5% after PK-TURP in this study is comparable to contemporary series. A slow resection rate seems to be related to US occurrence. This should be confirmed by further studies; meanwhile, we must be mindful of this possibility when operating with the PK-TURP system.

Keywords: Risk factors; Transurethral resection of prostate; Urethral stricture

INTRODUCTION

Transurethral resection of the prostate (TURP) is the gold standard surgical treatment for benign prostatic hyperplasia [1-4]. It remains the surgery of choice because of its proven long-term efficacy and durable outcomes [2,5]. TURP has traditionally been performed with the monopolar (M-TURP) system. In the past decade, the bipolar system

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(B-TURP) has gained popularity because of its better safety profile compared with M-TURP [2,6,7].

However, there are concerns that B-TURP could increase the occurrence of urethral stricture (US). This issue was first raised by Tefekli et al. [8] in their study on B-TURP with the Gyrus PlasmaKinetic Tissue Management System (PK-TURP). Subsequently, several later studies and 2 meta-analyses contradicted the earlier claim [1,2,9,10]. Those studies supported the opinion that US rates after B-TURP and M-TURP were similar. The controversy continued as data from 2 randomized controlled trials (RCTs) comparing M-TURP and B-TURP started to mature [11,12]. The longer-term follow-up (36 months) results of these studies showed contrasting US rates after B-TURP. Mamoulakis et al. [11] in their RCT found no significant difference in US rates between M-TURP and B-TURP with the AUTOCON II 400 (Karl Storz, Tuttlingen, Germany) system. On the other hand, Komura et al. [12], in another RCT, discovered a markedly higher US rate after B-TURP using the TURis system (Olympus, Tokyo, Japan) compared to M-TURP.

Even though several postulations have been put forward to explain the higher US rate related to B-TURP, more knowledge in this area is needed to improve on this technology [11]. Besides the peculiar B-TURP current flow pattern, we believe that other clinical and surgical factors contribute to US formation in B-TURP. This study aimed to determine the US rate after B-TURP, specifically, after PK-TURP. We also sought to identify clinical and surgical risk factors that affect US formation after PK-TURP.

MATERIALS AND METHODS

This study was an age-matched case-control study of US occurrence after PK-TURP. Approval was obtained from Universiti Kebangsaan Malaysia Medical Centre Research and Ethics Committee (approval number: FF-2013-324). All patients who had undergone PK-TURP with the bipolar Gyrus PlasmaKinetic Tissue Management System (Gyrus ACMI, Southborough, MA, USA) between 2003 and 2009 were included. PK-TURP was performed with a size 26F continuous flow resectoscope. The power settings used were 200 W when cutting and 100 W for coagulation.

Patients who had a minimum of 36 months of post-operative follow-up data were included. The information was collected from the urology unit's database as well as hospital records. Patients with missing or grossly inadequate data were excluded. All cases of US that occurred in this cohort were included as cases. These patients presented with voiding symptoms, and the presence of stricture was confirmed by endoscopic examination. Controls were patients without US, selected at random and matched by age from the same cohort. About four controls were included for every case of US. Data on patient demographics, prostate-specific antigen level, estimated prostate volume, amount of prostate resected, operating time, and duration of catheterization after surgery were collected. The rate of resection was calculated for each patient by dividing the amount of prostate resected by the operating time. Other information such as history of urinary tract infection (UTI), previous TURP, and whether the PK-TURP was combined with another procedure were all recorded. It was also noted whether the cases with US were operated on by a consultant urologist or otherwise.

The data were analyzed by using IBM SPSS Statistics ver. 23.0 (IBM Co., Armonk, NY, USA). Continuous data that did not follow a normal distribution were presented as medians (interquartile range) and compared by using the Mann-Whitney U-test. Factors associated with US after PK-TURP were determined by multiple logistic regression, comparing the case and control groups. Categorical variables were presented as percentages and analyzed with Fisher exact test. A p-value of <0.05 was considered statistically significant.

RESULTS

A total of 373 cases of PK-TURP were performed between 2003 and 2009. Thirteen cases of US after PK-TURP were identified in this cohort, giving a rate of US occurrence of 3.5%. These cases could be classified as Clavien-Dindo grade III complications because they all presented with symptoms that required treatment in the form of surgical or endoscopic intervention. Six of these 13 patients had PK-TURP performed by a consultant urologist, whereas the remaining 7 patients had their surgeries done by a trainee in urology under the supervision of a consultant. Most of these patients (8 of 13, 61.5%) presented with US within 12 months of the PK-TURP. Ten of the 13 patients (76.9%) with US presented within 24 months of PK-TURP. The median time to presentation of US was 8 months (range, 2–80 months) after PK-TURP. The majority (11 of 13, 84.6%) of the US cases occurred at the bulbar urethra. The other two cases had US at the proximal penile urethra.

Fifty-five age-matched controls were included for analysis. The mean ages of the cases and controls were 67.08±7.68 years and 69.75±6.59 years, respectively (p=0.206). The univariate analysis showed that a smaller amount of prostate resected and a slower resection rate were

Table 1. Univariate analysis of factors affecting urethral stricture occurrence

Variable	Stricture	No stricture	p-value
Duration of catheterization after surgery (d)	2.50 (2.00–4.00)	2.00 (2.00–3.00)	0.450
Estimated prostate weight (g)	35.50 (35.00–42.00)	40.00 (30.00–50.00)	0.514
Operative time (min)	60.00 (30.00–60.00)	60.00 (45.00–80.00)	0.151
Prostate weight resected (g)	8.10 (3.80–10.40)	23.30 (11.20–32.00)	0.013*
Prostate-specific antigen (ng/mL)	3.93 (3.16–9.79)	5.78 (2.34–12.32)	0.303
Resection rate (g/min)	0.14 (0.12–0.17)	0.36 (0.16–0.57)	0.034*

Values are presented as median (interquartile range).
*p<0.05, statistically significant difference.

Table 2. Multiple logistic regression analyses of the variables associated with urethral stricture occurrence

Variable	OR (95% CI)	p-value
Duration of catheterization after surgery	0.951 (0.782–1.157)	0.615
Estimated prostate weight	0.967 (0.902–1.035)	0.333
Prostate-specific antigen	0.967 (0.915–1.023)	0.242
Resection rate	0.003 (0.000–0.608)	0.032*

OR, odds ratio; CI, confidence interval.
*p<0.05, statistically significant difference.

Table 3. Categorical clinical and surgical variables associated with urethral stricture occurrence

Variable	Stricture	No stricture	p-value
UTI episodes	2 (15.4)	13 (23.6)	0.717
Previous TURP	1 (7.7)	6 (10.9)	1.000
Combined procedures	1 (7.7)	4 (7.3)	1.000

Values are presented as number (%).
UTI, urinary tract infection; TURP, transurethral resection of the prostate.

significantly related to US formation (Table 1). We then performed multiple logistic regression analysis and initially found a very high standard error for the variable "resection rate." We determined that this was due to collinearity with the variables "prostate weight resected" and "operative time." When these variables were removed from the final analysis, a slower resection rate was shown to be significantly associated with US occurrence (Table 2). Categorical variables like having a history of UTI, previous TURP, and PK-TURP being combined with another procedure did not influence the rate of US formation (Table 3).

DISCUSSION

The B-TURP technology was developed so that normal saline could be used as an irrigation fluid during the surgery. The PK-TURP system is an example of B-TURP, and it has been widely studied with regards to its efficacy and safety [2,9,11,13]. Its efficacy in studies with midterm analyses of up to 3 years is comparable to that of M-TURP [9,10]. The PK-TURP technique has been shown to reduce perioperative complications such as TUR syndrome, clot retention, and the need for blood transfusion [2,14]. TUR syndrome is less common because normal saline replaces glycine as the irrigation fluid in PK-TURP. The ability of the PK-TURP system to "cut-and-seal" [6,7] and possibly the deeper depth of coagulation help to explain why there is less blood loss when operating with this technology [14,15].

Despite these promising early results, a serious concern about PK-TURP's long-term outcome was brought to light when Tefekli et al. [8] reported a higher rate of US. Those authors, in an RCT, discovered a significantly higher rate of US formation after PK-TURP than after M-TURP. Mamoulakis et al. [16] later disputed this result and declared it statistically insignificant. Nonetheless, this worry has driven many researchers to postulate why the US rate may be higher with the PK-TURP system. Among the theories to account for a higher rate of US after PK-TURP are larger resectoscope size [8], longer operating time [17], and greater ablative energy [2,8,18].

With the emergence of level 1a evidence, it is now generally believed that the US rate is not greater after

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B-TURP than after M-TURP [1,2]. However, these results should be viewed with some caution because extended follow-up studies may alter this perception, especially if more cases of US begin to surface in the long run. To date, only a few studies are available with long-term follow-up data (>24 months) regarding the US rate after B-TURP [9-12,19,20]. None of these found a statistically significant difference in US rates after B-TURP and M-TURP except in one study by Komura et al. [12]. Their recently published study reported an exceptionally high US rate after B-TURP with the TURis system. It appears that US rates might differ even among the various B-TURP systems available in the market today. Therefore, this relation between B-TURP and US remains unsettled, and long-term observations are needed.

The present study, with 36 months of follow-up data, showed a rate of US occurrence of 3.5%. This concurs with figures from contemporary studies in which PK-TURP-related US rates were between 2.5% and 5.4% [2,9,10,13,21,22]. It is noteworthy that in our study more than three-quarters of US cases presented within the first 2 years of PK-TURP. The median time to presentation was 8 months after PK-TURP. This seems to suggest that if US formation did not occur in the first 2 years after PK-TURP, it is likely that the patient will be free from this complication in most cases. The majority of the US cases found in this study were located in the bulbar urethra, which could be due to the direction of the return current flow in the PK-TURP system. To explain this observation, we must consider the difference in the return current flow between PK-TURP and M-TURP.

The M-TURP system uses high-frequency electrical energy passed from a generator onto a cutting loop, which produces the intense heat needed to cut prostate tissue [3]. The circuit is completed by a return flow of the electrical current back to the generator. The return current flow of the M-TURP is directed via a return plate placed on the patient's skin. The PK-TURP design also utilizes high-frequency current passed from a generator onto a cutting loop. The interaction of this energy with normal saline produces particles that are charged, known as plasma, that can disintegrate tissue [3,23]. The return current flow of the PK-TURP is different because it is channeled back via the resectoscope itself, rather than through a return plate like the M-TURP system. Faul et al. [24] elegantly presented the electrical current flow patterns of these different systems in a review of the subject.

The M-TURP's return current flow is potentially spread over a large area because of the broad return plate that is used to complete the circuit. The PK-TURP configuration, on the other hand, creates a concentrated stream of return current as it flows back to a small returning point on the resectoscope [24]. This concentrated electrical energy has a greater potential to cause more thermal damage than the more dissipated return current flow of the M-TURP system.

Furthermore, the return current flow direction of the M-TURP could vary, depending on where the return plate is placed. Because of this, the flow of the return current might not necessarily flow past the bulbar urethra. In contrast, the return current of the PK-TURP is fairly constant because it has to flow back in the direction of the resectoscope. This arrangement exposes the bulbar urethra to a concentrated amount of electrical current, especially when the apical region is being resected, thus putting this area at risk of thermal injury. This could be why most of the US cases in this cohort occurred in the bulbar urethra. This postulated mechanism of injury was also highlighted by Komura et al. [12] to account for a greater US rate with the TURis B-TURP system.

When designing this study, we hypothesized that that other elements like surgical risk factors may affect US occurrence after PK-TURP. The results showed that a slow resection rate was significantly associated with US formation. We believe that there is a complex interaction between the current flow pattern of the PK-TURP system with this surgical risk factor to result in US formation. As discussed earlier, the fixed direction of the PK-TURP return current flow exposes the bulbar urethra to a concentrated stream of electrical energy. If the resection rate is slow, this part of the urethra will therefore be exposed to a large amount of electrical energy for a longer period of time. This translates to an increased potential for thermal damage and ultimately US formation.

It is interesting to note that Tao et al. [25] also recently reported that US is associated with slow resection rate. That study also found mucosal rupture of the urethra and continuous postoperative infection to be risk factors for US occurrence. However, it appeared that they included both PK-TURP and M-TURP in their data, and it was not clear whether slow resection affected both systems equally. To the best of our knowledge, we are only the second study to discover a possible detrimental effect of resecting too slowly with the PK-TURP system. This new understanding could help with patient selection and influence the surgical approach when embarking on PK-TURP. For instance, it would be prudent to avoid spending too much time resecting a relatively small prostate gland. In fact, TUIP might be more suitable for a patient with a smaller prostate gland because by minimizing operation time, we can reduce unnecessary exposure of the urethra to thermal damage. Additionally, while the favorable safety profile of PK-TURP might make it seem an attractive tool for training, the trainer should take care to monitor the resection rate of their trainees in light of the new information emerging from this study.

The retrospective design of this study had the inherent limitations of selection bias and completeness of data for analysis. Great care was taken to ensure that accurate data were included in the analysis. This was achieved by diligent searching for critical information from the database and hospital records available to us. We accept that the present study design cannot categorically prove the reasons behind US formation after PK-TURP. Nevertheless, it provides information that could influence our clinical judgment and also form the basis for new hypotheses in future research into this topic. There is a need to have a greater understanding of the technology that we currently use and how some of these tools could lead to certain undesirable effects. Such tools can then be improved to produce better outcomes for our patients.

CONCLUSIONS

In conclusion, US occurred at a rate of about 3.5% after PK-TURP in the present cohort, which is comparable to contemporary M-TURP series. Most cases will present within 24 months of surgery. A slow resection rate appears to be associated with US formation. We postulate that this risk factor is intimately associated with the returning current flow of the PK-TURP system to cause US. While this possibility should to be confirmed with further studies, it should be taken into consideration when operating with the PK-TURP system.

CONFLICTS OF INTEREST

The authors have nothing to disclose.

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